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INFLUENCE OF DIFFERENT LEVELS OF XYLANASE ENZYME ON PERFORMANCE, LITTER QUALITY AND ECONOMICS OF BROILER CHICKEN

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ABSTRACT

An experiment was carried out on 300 one day old straight run commercial broiler chicks to assess the effect of different levels of xylanase enzyme on performance parameters. The experimental design consists of 4 treatment groups with three replicates consisting of 25 birds per replicate. Treatment group A served as control diet. The ration was prepared with reduced energy (-100 kcal/kg) for treatment group B without addition of xylanase as negative control. The treatment groups C and D rations were prepared with reduced energy by 100 kcal/kg and supplementation of xylanase enzyme @ 60 and 100 g/ton of feed respectively. The results revealed significantly higher cumulative weight gain for xylanase supplemented groups compared with non supplemented groups. Significantly higher cumulative feed consumption was observed for the birds reared on negative control ration (-100 Kcal/kg) treatment group B. Xylanase supplemented groups revealed significantly better FCR compared to negative control group. Significantly higher mortality was noted in negative control group. Highly significant k9differences were observed for moisture content and pH of litter among various treatment groups. The net profit per Kg live weight was highest for treatment group D supplemented with xylanase at 100g/ton of feed. Overall results in the present study concluded that supplementation of xylanase enzyme @ 100 g/ton of feed in broiler ration is more beneficial in higher fiber containing diets for improvement of performance, livability, litter quality and profitability in commercial broiler chicken.

KEYWORDS: Xylanase, Performance, Economics, Litter Moisture & Litter

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Original Article

INTRODUCTION

The benefits of using enzymes in mono gastric diets include not only enhanced growth performance and feed conversion, but also fewer environmental problems due to reduced output of excreta (8). Enzymes decrease the viscosity of gut contents, resulting in improvement in nutrient digestibility and performance when added to poultry diets (12). Enzyme supplementation counteracts anti nutritional effects of non starch polysaccharides (NSP), reduces the intestinal viscosity and the nutrient encapsulating effect of cell wall which in turn could result in increase in protein, starch and energy utilization (4). Avian species do not produce enzymes capable of degrading NSP, may undergo bacterial fermentation in the caeca and colon to produce short chain fatty acids (SCFA) (27).

Xylanase is a major component of the fiber in cell walls in both viscous (wheat, rye, barely) and non viscous (corn and sorghum) cereals. Thus the addition of xylanase to mono gastric diets based on such cereals would be expected to improve broiler performance. Xylanase supplementation improved live weight in chicken and had no effect on survivability (2).

Very little information is available on the use of xylanase enzyme alone in maize based diets for any species (12&17). The xylanase enzyme targets the NSPs, resulting in plant cell wall destruction and thereafter the nutrient release. The breakdown of NSPs leads to production of short-chain oligosaccharides (di- and tri-saccharides) creating substrate for bacterial fermentation, favorably altering bacterial populations within the gut. With increasing concentration of soy products, soluble NSPs form a viscous gel that entrap nutrients and slows down the passage rate of digest, reducing feed intake and subsequently growth (13).

Maize is the principal cereal used as a source of energy in broiler diet in majority part of the World and it is of paramount importance whether feed enzyme is beneficial in improving the performance in diets where soluble NSPs concentration are relatively low (23). The supplementation of xylanase to wheat-based diets cuts the arabinoxylan backbone into small fragments (mainly arabinose and xylose) in the ileum, jejunum and duodenum, and enhances digestibility of nutrients by decreasing digesta viscosity. The release of arabinose and xylose in kthe small intestine may also be the important contributors to the growth-promoting effect of xylanase in broilers fed wheat-based diets (36). It is a general phenomenon that higher dietary fiber increases the litter moisture content and the same has been reported by many researchers. NSP degrading enzymes have been claimed to reduce litter moisture by virtue of their ability to digest dietary NSPs.

Maintaining the maximum fiber level along with incorporation of xylanase enzyme as a fiber degrader in broiler feed resulted in positive effect on growth performance and better cost benefit ratio. However, there are inconsistent and very few reports in literature, hence the present study was planned to evaluate the effects of different levels of xylanase enzyme with increasing fiber percent in the diets and its effect on performance of broilers.

MATERIALS AND METHODS

Housing and Experimental Design

The experiment was carried out on 300 day old Vencobb-400 straight run commercial broiler chicks for a period of 42 days (from 20th January 2016 to 2th April 2016) in the Department of Poultry Science, College of Veterinary and Animal Sciences, MAFSU, Parbhani. Xylanase enzyme (Econase XT®) was supplied by AB Vista, South Asia, Pune. The enzyme consists of beta 1-4, endo-xylanase, developed for use in monogastric feeds having a xylanase activity equivalent to 160,000 BXU/g and added in the feed @ 60gm and 100gm/ton of feed for the treatment groups C and D respectively, throughout the experiment period. The experimental design used for housing the broilers is presented in Table 1.

Table 1: Experimental Design used for Housing of Broilers

Treatment Group	Treatment Group Details	No. of Birds/Pen/ Replication	No. of Replication	Total Number of Birds
A	Standard Control group	25	3	75
B	Negative control(-100 kcal /kg) energy	25	3	75
C	Treatment B + Xylanase (60 gm/ton of feed)	25	3	75
D	Treatment B + Xylanase (100 gm/ton of feed)	25	3	75
Total Number of Birds				**300**

The birds were randomly distributed with maintaining 50:50 sex ratios to form the experimental groups. The one square feet floor space was provided for all the treatment groups.

Feed Formulation and Feed Ingredients

The feed ingredients used in the present experiment were purchased from local market and rations were prepared as per (5) at Feed Mixing Plant, College of Veterinary and Animal Sciences, MAFSU, Parbhani.

Table 2: Percent Ingredient and Nutrients Composition of Feed Starter, Grower and Finisher Ration of Broiler Chicken

	Treatment Group A			Treatment Group B			Treatment Group C			Treatment Group D		
Feed Ingredients	**Starter**	**Grower**	**Finisher**	**Starter**	**Grower**	**Finisher**	**Starter**	**Grower**	**Finisher**	**Starter**	**Grower**	**Finisher**
Maize	52.4	50.6	51.8	50.9	50.6	50.95	50.9	50.6	50.95	50.9	50.6	50.95
Wheat	1.5	1.7	4	2	1.7	4	2	1.7	4	2	1.7	4
Vegetable oil	1.8	3.9	5.2	0.8	2.5	4	0.8	2.5	4	0.8	2.5	4
Soy DOC	40.5	38	30.75	39.5	37.5	30.25	39.5	37.5	30.25	39.5	37.5	30.25
DORB	1	3	5.45	4	4.9	8	4	4.9	8	4	4.9	8
DCP	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
LSP	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100	100	100	100	100	100	100	100
Supplements/Additives (g/100kgs)												
Mineral mixture*	300	300	300	300	300	300	300	300	300	300	300	300
Vitamin mixture**	150	150	150	150	150	150	150	150	150	150	150	150
Methionine	180	190	160	180	190	160	180	190	160	180	190	160
Lysine	170	130	100	170	130	100	170	130	100	170	130	100
Choline chloride	60	60	60	60	60	60	60	60	60	60	60	60
Xylanase (g/100kg)	Nil	Nil	Nil	Nil	Nil	Nil	6	6	6	10	10	10
C P (%)(calculated	23.10	21.99	19.93	23.07	22.07	20.03	23.07	22.07	20.03	23.07	22.07	20.03
M E (Kcal/kg) (calculated)	3002	3106	3200	2902	3005	3100	2902	3005	3100	2902	3005	3100
E:P ratio	130:1	141.:1	161:1	126.:1	136.:1	155:1	126:1	136:1	155:1	126.:1	136:1	155:1
Fiber %	3.5	3.5	3.5	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

*__Mineral Mixture:__ Copper, ferrous, zinc, iron.

**__Vitamin Mixture:__ Vit. A, D, E, K & Vit B Complex (Riboflavin, thiamine, Choline, pantothenic acid, niacin, pyridoxine, biotin, cynocobalamine).

Feeding and Watering Schedules

Weighed quantity of the ration was offered every day in the morning to all the treatment groups. The left over feed was collected and weighed separately on the first day morning of second week and onward of each week to arrive at the actual weekly feed consumption, which was inclusive of feed losses, if any. The birds were offered *ad-lib* fresh and clean drinking water throughout the experiment.

Data Collection

Data were collected on weekly weight changes was determined by weighing the birds on weekly basis and weight gain was calculated by subtracting the weight of the previous week from that of the current week. The feed intake was determined by subtracting the left-over feed from the feed offered, while feed conversion ratio was calculated as average feed intake divided by average /weight gain. The mortality was recorded daily and the weights of all the dead birds were

taken in order to minimize an error in feed conversion ratio. It was expressed as percentage mortality at the end of the experiment for corresponding treatment group.

Moisture Percentage of Litter Material

The litter samples were collected from four locations within each pen. (Four peripheral, equidistant from each pen corner) and thoroughly mixed to obtain material representative of the entire pen. At least 200 gram of litter was placed in a plastic container and a subsample was taken for further analysis at the laboratory. The litter moisture samples were collected, mixing and obtaining a 100 gram litter subsample, placed in 15x30 cm tray and oven-dried for 48 hours at 60*C. The percentage of moisture was calculated by using the weight loss between initial and dried litter (31) by using following formula.

$$\text{Moisture\%} = \frac{\text{(initial wt – dried wt)}}{\text{initial wt}} \text{X100}$$

Where Wt = weight

Estimation of pH of Litter Material

The upper 10 cm of the litter was collected at each sample position for determination of pH. The pH of each sample was measured after litter samples of nearly 5 gram were suspended for 30 min in 25 ml of distilled water and stirred for 5 min using a pH meter (19).

Economics of Broiler Production

The cost of rearing the chicks for complete experiment was calculated by taking into consideration the cost of chick, cost of total feed consumed by bird, cost of litter, vaccination, medication expenses however the labour cost was not considered as the experiment was conducted by student. Gross profit per bird was calculated by subtracting the cost of production per bird from the price fetched per bird after selling it in the local market on live weight basis.

Statistical Analysis

All the generated data were subjected to statistical analysis (ANOVA) by using Complete Randomized Design (29). The treatment means were compared by critical differences (CD) and Analysis of Variance.

RESULTS AND DISCUSSIONS

Cumulative Weight Gain

The results showed highly significant ($P < 0.01$) difference among various treatment groups in weight gain. The treatment D recorded highest cumulative weight gain, followed by treatment group C, A, and B. The treatment group C and D differ significantly from treatment group A and B. The weight gain of broilers fed with xylanase supplemented diets was significantly higher than that of un-supplemented diets even though the diets were prepared by reducing energy content (-100kcal/kg) of feed. It inferred that the improvement in body weight was due to enzyme supplementation which might have attributed to efficient degradation of fiber content of wheat, corn and de-oiled rice bran. Similar findings were also reported by (26) who reported that addition of enzyme to the diet containing 6% crude fiber significantly improved body weight in broilers compared to that of control groups fed with same diet without enzyme. (22&23) also revealed that the body weight gain of broilers fed with treatment diet was more in xylanase supplemented diet than control diet.

Table 3: Cumulative Weight Gain (G), Feed Consumption, FCR, Mortality, Litter Moisture and Ph of Broiler with Supplementation of Xylanase Enzyme

Age (Weeks)	Groups/Treatments			
	Cumulative Weight Gain			
	A (Standard Control Diet-)	B (-100 kcal./kg)	C (Treatment B +xylanase 60gm/ton of Feed)	D (Treatment B +xylanase 100gm/ton of Feed)
I	87.13	82.59	121.01	122.77
II	242.27	230.69	249.43	372.00
III	483.69	451.56	485.91	762.25
IV	812.56	784.86	847.86	1259.76
V	1309.43	1244.50	1365.26	1832.50
VI	1859.87	1837.31	1922.00	1939.67
Overall	799.15^{b}	771.91^{b}	831.91^{a}	841.93^{a}
Cumulative feed consumption				
I	95.04	92.52	94.76	101.99
II	338.92	352.73	351.32	343.68
III	731.15	777.95	775.63	766.84
IV	1338.78	1435.49	1421.52	1397.41
V	2179.25	2384.81	2273.35	2229.19
VI	3294.65	3589.86	3424.91	3386.63
Overall	**1329.63^{b}**	**1438.89^{a}**	**1390.24^{b}**	**1370.95^{b}**
Cumulative FCR				
I	1.09	1.12	0.78	0.89
II	1.40	1.52	1.41	1.35
III	1.51	1.72	1.59	1.50
IV	1.64	1.83	1.67	1.59
V	1.66	1.91	1.66	1.64
VI	1.77	1.95	1.78	1.74
	1.51^{b}	**1.67^{a}**	**1.48^{b}**	**1.45^{b}**
Mortality (%)				
Overall	**2.66**	**5.33**	**1.33**	**1.33**
Litter quality				
Moisture (%)	**14.2^{c}**	**20.23^{a}**	**19.37^{a}**	**16.73^{b}**
pH	**6.25^{b}**	**7.08^{a}**	**6.94^{a}**	**6.91^{a}**

Table 4: Analysis of Variance for Cumulative Weight Gain (G), Feed Consumption, FCR, Mortality, Litter Moisture and Ph of Broiler with Supplementation of Xylanase

		Cumulative Weight Gain			Cumulative Feed Consumption			Cumulative FCR		
Source	**DF**	**SS**	**MSS**	**F ratio**	**SS**	**MSS**	**F ratio**	**SS**	**MSS**	**F Ratio**
Groups	3	18370.46	6123.486	15.14**	37011.21	12337.07	4.777936**	0.17198	0.057327	15.55214**
Weeks	5	9422661	1884532	4659.7**	32245999	6449200	2497.664**	1.864224	0.372845	101.149**
Error	15	6066.511	404.4341		38731.38	2582.092		0.055291	0.003686	
Total	**23**	**9447097.97**			**32321742.**			**2.091596**		

Cumulative Feed Consumption

The results showed that cumulative feed consumption revealed highly significant ($P < 0.01$) difference among various treatment groups. An increased feed consumption in negative control groups can be justified as high crude fibre in the diet limits energy access and also NSPs in the fibre contacts with water and forms a gel fibre that reduces passage time and absorption of nutrients and thus, increases feed consumption to compensate and meet nutritional demands. This significant increase in feed consumption was also reported by (28), (34), (20), (21) (30), (14), (18), and (4) respectively.

Cumulative Feed Conversion Ratio (FCR)

The statistical analysis of variance for cumulative feed conversion ratio of broilers with different levels of xylanase enzyme revealed highly significant ($P < 0.01$) influence. The superior feed conversion ratio was found for treatment group D followed by C and A. The comparatively inferior feed conversion ratio was found for treatment group B with reduced energy level. The results clearly inferred that feed conversion of chicken in energy deficient diet supplemented with xylanase enzyme was found to be superior than that of normal control group (A). The present findings

are in accordance with (16) who reported that FCR was significantly improved by the addition of xylanase enzyme and was effective in diets based on viscous cereals through a mechanism of gut viscosity reduction. Also, similar findings were reported (22&23) with significant improvement in feed efficiency in the Xylanase supplemented groups. In contrast to the present study (7), (35), (39), and (4) reported Xylanase supplementation had no significant influence on feed efficiency during overall growth phase.

Mortality

Significantly lower mortality in xylanase supplemented groups, with reducing energy level compared to non supplemented group clearly indicated that anti-nutritional factor and low energy level might be contributing factors for increasing the mortality in negative control group (B). The findings in the present study are in agreement with (10). They revealed that the mortality of birds supplemented with xylanase tend to lower compared to non supplemented birds. Similarly (21) also revealed that Xylanase supplementation resulted to significant decrease in the mortality rates. The maximum mortality was observed in broilers in negative control groups compare to that of xylanase treated groups as per the findings (4). However, in contrast to the present study (27), (6), (11) and (3) reported non significant findings with respect to mortality.

Moisture Percentage of Litter Material

The analysis of variance (Table 4) showed highly significant ($P < 0.01$) differences among the various treatment groups for moisture percentage of litter at 42 days. The findings clearly indicated that xylanase supplemented group (D) at a higher dose decreased the moisture content of litter compared to negative control group (treatment group B) with a higher fiber percentage. This significant reduction in the moisture content of excreta was due to decreased gut viscosity and improvement in birds health due to prevention of diseases associated with the proliferation of gut microflora. Majority of the anti nutritional activity of NSPs in poultry by virtue of their capacity to increase intestinal viscosity and modulate gut microflora. It is well recognized that increased viscosity decreases the digestion and absorption rate in the lumen by changing gastrointestinal functions. In wheat based diet, with higher crude fiber reduced performance was related to an increased in intestinal viscosity. Furthermore, increased intestinal viscosity alters lipid and protein digestibility. The addition of xylanase might have degraded soluble NSPs and thereby reduced viscosity and improved performance. Similar findings were reported by (8), (15), (9) and (3). However, (25), (27) and (6) reported non- significant effect of supplementation of enzyme on litter moisture of broiler chicken.

pH of Litter Material

The results of pH of litter material are presented in (Table 3) showed significant differences ($P< 0.01$) among the various treatment groups. Treatment group A having significantly lower pH compared to rest of the treatment groups. Even though numerically higher litter pH value was observed for non supplemental enzyme group with reduced energy level (B) compared to enzyme supplemented at different levels group, however, the differences were statistically non significant. Similarly (6) reported pH of litter material at 42^{nd} day did not differ significantly among treatment groups. However, these authors did not formulated energy deficient diet unlike to that of present study. The results clearly indicated that all treatment groups deficient in energy supplemented with xylanase numerically reduced litter pH compared to un-supplemented groups.

Economics of Broiler Production

The economics of broiler production from different treatment groups is presented in Table 5. The cost of day old chicks, feed, medication, vaccination, litter and other overheads were considered while calculating the cost of production. However, the costs of labour were not considered in calculating the cost of production of the broilers as this experiment being a postgraduate research work.

Table 5: Economics of Broiler Production with Supplementation of Xylanase

Sr. No.	Particulars	Treatment Groups			
		A(standard Control Diet)	B(100 kcal. Energy Less)	C(Treatment B +Xylanase 60gm/ton of Feed)	D(Treatment B +Xylanase 100gm/Ton of Feed)
1	Cost of day old chick (Rs)	28	28	28	28
2	Feed consumption (g)				
i)	Prestarter	338.92	387.12	351.32	343.68
ii)	Starter	999.86	1080.25	1070.20	1053.73
ii)	Finisher	1955.87	2122.49	2003.39	1989.27
	Total	**3294.65**	**3589.86**	**3424.91**	**3386.68**
3	Rate of feed (Rs/kg)				
i)	Prestarter	28.56	27.70	27.76	27.80
ii)	Starter	29.21	28.24	28.30	28.34
iii)	Finisher	28.21	27.35	27.41	27.45
4	Cost of feed consumed (per bird Rs.)				
i)	Prestarter	9.68	10.71	9.74	9.53
ii)	Starter	29.21	30.49	30.28	29.84
iii)	Finisher	55.17	58.03	54.90	54.59
	Total Cost of Feed Consumed Per Bird (Rs.)	**94.06**	**99.23**	**94.92**	**93.96**
5	Miscellaneous cost* (Rs)	8	8	8	8
6	Total cost of production (1+4+5)	130.06	135.23	130.92	129.96
7	Average live weight (g)	1896.04	1873.64	1958.17	1976.01
8	Return obtained @ Rs. 79 per kg live weight	149.78	147.96	154.68	156.10
9	Net Profit/Bird (Rs.)	19.72	12.73	23.76	26.14
10	Net profit/ kg (Rs)	10.40	6.79	12.13	13.22

Significant finding in the present study that net profit per bird was highest in treatment group D (Rs.26.14) supplemented with xylanase @ 100g/ton. of feed. Similarly, higher profit also observed in treatment group C (Rs.23.76) supplemented with xylanase @ 60g/ton. of feed. It concluded that the nutrient reduced diet (-100kcal/kg) supplementation with xylanase significantly influenced the weight gain, feed consumption and FCR there by reduced the cost of production and ultimately increased net profit. The findings of present study in agreement with the findings of (14). They reported that net profit per bird was found to be Rs. 25.80 by xylanase enzyme supplementation. (3) reported that addition of xylanase enzyme in low diet energy allows the producers to raise birds with an economic feed benefit cost and contribute to enhance broiler chicken production. (5) Concluded that supplementation of xylanase enzyme in high fiber diet may have better cost benefit ratio than that of low fiber diet without enzyme. Similarly, (22 & 23) showed that xylanase supplemented corn – soya sub -optimal diets at high concentration had evolved as an economic combination for broilers

Based on present study, it is concluded that the supplementation of xylanase @ 100 g/ton. of feed in broiler ration

is more beneficial for improvement of performance, livability, litter quality and profitability in commercial broiler chicken.

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